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SPECIAL ARTICLES

MILK EPIDEMICS OF SEPTIC SORE THROAT IN THE
UNITED STATES AND THEIR RELATION
TO STREPTOCOCCI

In England epidemics of sore throat, bearing some relation to the milk supply, were recognized as early as 1880 (Rugby). Since then a number of such epidemics have occurred and in those in which the etiology was investigated, streptococci were uniformly found as the infectious agent. In some of these epidemics there were reasons to believe that udder or teat infections were the source of the organisms; in others the evidence seemed to point to a milker or handler as the source.

In the United States the first epidemic of sore throat recognized as having a definite relation to the milk supply appeared in Boston in 1911 and was carefully investigated by Winslow.¹ There is no doubt, I think, that many such epidemics have occurred in the past in this country, as well as in other countries, but on account of the almost universal prevalence of ordinary colds and sore throats their epidemic character and origin was not recognized. Indeed, in the medical literature there are references here and there to outbreaks of severe colds and other similar infections associated with serious and fatal complications, such as peritonitis. It is not unlikely that such epidemics originated from a contaminated milk supply since we know that these milk epidemics are, as a rule, serious infections followed often by severe complications. In the case of milk epidemics of scarlet fever, diphtheria and typhoid fever, it may be pointed out that formerly their possible relation to the milk supply was not recognized or was denied, and only recently, when more intensive studies of such epidemics were made, was their true relation to milk supply established.

Since the Boston epidemic of 1911, similar outbreaks have been reported from Chicago, Baltimore, Boston (1912), Concord, N. H., Cortland and Homer (N. Y.), Wakefield and

Stoneham (New York) and Jacksonville, Ill. The number of persons stricken in these various epidemics has been estimated as follows: Boston, 1,400, Chicago 10,000, Baltimore 1,000, Boston (1912) 227, Concord 1,000, Wakefield and Stoneham 1,000, Cortland and Homer 669, Jacksonville 348; making a total of nearly 16,000. Probably many more than this number were affected since the above are all conservative estimates. This number is sufficient to at least give one some idea of the magnitude and importance of this type of infection.

In all, the onset, the character of the symptoms, and the later complications are strikingly alike and, it may be said, they agree in this respect with the epidemics in England. Furthermore, the relation to the milk supply appears to be unquestionable in all. The interesting fact stands out that there is a certain uniformity in the reports in that the contaminated milk, though used perhaps by a small proportion of the people, still furnished a very high proportion (70, 80 or 90 per cent.) of the reported cases. The remainder of the cases probably resulted from personal contact or from some other means.

Streptococci were unquestionably the cause of the disease in all the epidemics, being found abundantly in the throats or in the secretions of the sick persons in all the cases investigated. This fact is of great importance because it establishes definitely the etiology, and since the clinical symptoms in all the epidemics are so strikingly uniform, we may consider these infections as a definite clinical entity. They should, I think, take their place and be considered in text-books in medicine along with other infectious diseases, such as scarlet fever, measles, typhoid fever and the like.

As regards the nature of the streptococci, there is a fair degree of uniformity so far as the reports of the various investigators permit one to judge. They are all virulent, usually highly so, for animals. In general, they correspond, with only slight variations, in their morphology, in their cultural characteristics, and in their biological properties. In certain respects there seem to be some

¹ *J. Inf. Dis.*, 1912, X., 73.

slight differences between these streptococci and the ordinary *Streptococcus pyogenes*, and these differences have been sufficient to lead to the use of the special term *Streptococcus epidemicus* for them. It should be stated that it may be questioned whether or not the differences between them and the *Streptococcus pyogenes* are sufficient to justify such a distinction. They may be simply highly virulent strains of ordinary *Streptococcus pyogenes* whose properties have been modified by animal passage.

In some of the reports, particularly the earlier ones, and this is especially true of the English epidemics, descriptions of the streptococci are not given in detail. In certain instances this could not be done because the epidemic was practically over before its study was undertaken. It is unfortunate that this is so, because it is very important that the organisms from each of these epidemics should be carefully studied in order that the results may be correlated. It may not be out of place here to call the attention of physicians and health officials to the importance of such studies. Especially should the local physicians and health officers in small communities and towns be on the lookout for such epidemics, for it is they who meet these cases early, the time most suitable naturally for the isolation and study of the causative agent. Such physicians and health officers should see to it therefore that a careful bacteriologic study be undertaken as soon as possible. If they have not the means at hand or for any reason do not care to undertake such a detailed study, they should send the material to some laboratory where this can be done. The writer would be glad to examine such organisms with a view to identification and requests any who may desire to do so to send such material to him.

It may be stated that in the future it is probable that the small community will be affected by such milk epidemics more frequently than the larger cities since the milk products are apt to be less carefully handled and pasteurization will less often be required than in larger places.

One of the properties noted in the strep-

tococci from nearly all the epidemics is that of hemolyzing blood when the colonies are grown on human or rabbit blood agar plates. While there has been slight variations in the strains studied, they have been strikingly alike in this respect. By hemolysis is meant that a well-defined wide clear zone appears about the colonies in 24 hours at incubator temperature. It does not mean a slight halo occurring about the colonies nor does it mean a slight narrow ring of cleared media developing perhaps after 48 hours or more as occurs with certain strains of organisms. This property is of great importance because it is a very ready and practical means of differentiating such organisms from the common *Streptococcus lacticus* (*Bact. g ntheri*) which are not hemolytic. These latter are practically always present in normal milk, and so far as we know are of no sanitary significance. It should be pointed out that there are other perhaps more reliable but less practical means of determining the hemolytic power of bacteria than the simple plate method. I refer to such methods as those of Lyall² and Marmorek³ which should be used as confirmatory tests, where they are of real value.

It is not to be understood that every hemolytic streptococcus is necessarily virulent or dangerous to man. But finding them in any considerable number in milk should make one very suspicious of udder disease, and such milk should at once be excluded from use.

The question of the source of streptococci causing these epidemics of sore throat is an important one. Two possible sources are recognized: the one bovine—the udder or teats of the cow; the other human—some lesion in the throats, hands, etc., of a milker or handler. It is often a difficult matter to absolutely prove in a given case whether or not the infection is bovine or human in origin. This is because practically identical hemolytic streptococci occur in the diseased udders of cows and also in the throats and on the hands of milk handlers. Furthermore, both streptococcal infections of udders in cows and streptococcal

² *Jour. Med. Research*, 1914, XXX., 487.

³ *Ann. de l'Inst. Past.*, 1902, XVI., 172.

infections in the human are relatively common; consequently, in an investigation of large numbers of cows and of milk handlers, as it is usually necessary to do in studying these epidemics, one is very apt to find instances of one or the other and hence draw conclusions accordingly. On the other hand, the real source of streptococci may be overlooked on account of some hidden focus of infection in the throat or tonsils of a milker which could not be detected in an ordinary throat examination. Or a cow might be suffering with inflammation of the udder and discharging millions of streptococci in the milk and still, as the writer has shown experimentally, the udder may show no physical signs of disease and might thereby escape detection on inspection. For these reasons it is readily seen how one might be misled in his conclusions when looking for the ultimate source of streptococci causing an epidemic.

In the Boston epidemic the source of the streptococci was not clear, Winslow stating that it was probably a carrier. In the Chicago epidemic, certain facts suggest that the origin was bovine, but absolute proof was lacking. Stokes and Hatchell from their investigations of the Baltimore outbreak "feel reasonably sure the infection was caused by streptococci of the epidemicus type from cases of mastitis among the herds supplying the dairy."⁴ In the report of the Concord, N. H., epidemic, made by Mann⁵ no mention is made of a possible bovine source. There was evidently sufficient opportunity for contamination of the milk by human carriers on the farms supplying the milk. In the Wakefield and Stoneham (N. Y.) epidemic reported by Morse,⁶ a very definite connection seemed to exist between the epidemic and a throat abscess in one of the milkers. In the report of the Cortland and Homer epidemic made by North, White and Avery, the statement is made that "two cows having inflamed udders in the herd of Dairy X were undoubtedly responsible for the epidemic of septic sore

throat."⁷ At Jacksonville, Ill., the epidemic, studied by Dr. J. A. Capps and the writer, was caused by hemolytic streptococci and from two cows supplying milk to Dairy X the same type of organisms were isolated. No suspicious human carriers could be found on the farms or among the milk handlers.

From the above it is seen that bovine and human sources are suspicious, and perhaps each or both at times may be responsible. It is known that human streptococci may be highly virulent for cows⁸ and the reverse may also very probably be true. In an analysis of milk organisms, therefore, the fact that hemolytic streptococci have been the cause in probably all the sore throat epidemics centers our attention at once upon this type of streptococcus. As yet there is no evidence that other types have any sanitary significance whatever so far as sore throat or any other human disease is concerned. I therefore call attention to the fact that in any investigation of milk streptococci, whether from the standpoint of pure or applied bacteriology, the relation of the streptococci to hemolysis of blood should be carefully noted. It is well known, of course, that hemolysis may not be an absolutely stable property in any given strain. A strain may occasionally alter its power in this respect just as it may change its fermentative properties under certain conditions. For practical purposes, however, it is of very great value, as I believe every one who has occasion to work with pathogenic streptococci will admit. Furthermore, the fact that the hemolytic property can not be correlated with other properties such as those of fermentation does not detract from its value as a differentiating feature, but rather adds to it.

The question of pasteurization is an interesting one in relation to these infections. In the case of at least four of the epidemics in this country the infected milk had been pasteurized by the "flash" method and the evidence in all indicated quite clearly that the milk was contaminated before pasteurization. Nothing further need be said, therefore, con-

⁴ Public Health Reports, 1912, Vol. 27, p. 1923.

⁵ *Jour. of Inf. Dis.*, 1913, 12, 481.

⁶ *Am. Jour. Pub. Health*, 1914, 4, 506.

⁷ *Jour. Inf. Disease*, 1914, 14, p. 132.

⁸ Davis, *Jour. Inf. Dis.*, 1914, 15, 135.

cerning the absolute inefficiency of the "flash" method. The harm it may do by giving the people a sense of false security is also self-evident. In the remaining epidemics the milk was consumed raw. It would seem that our only safeguard against such epidemics is efficient pasteurization not only of the milk and cream, but also of the material entering into the manufacture of other milk products. It is a point of some importance that it is not uncommon for firms to sell pasteurized milk, but to sell cream in the raw state. The latter of course may be even more dangerous than milk.

The question as to what constitutes efficient pasteurization for streptococci is one that evidently requires further study. It is commonly stated in the literature that pathogenic streptococci are killed at relatively low temperatures (52° – 54° C. for 10 minutes Sternberg). Undoubtedly for many strains this is altogether too low. The recent work of Ayers and Johnson⁹ indicates that the thermal death point of typical streptococci varies considerably and one of 22 strains studied by them resisted heating for 30 minutes at 62.8° C. (145° F.), the usual temperature for pasteurizing. Furthermore, their viability in milk and milk products should be carefully studied since we know the media may exert an important effect on the resistance of organisms to heat. The pasteurization process may therefore have to be modified accordingly to meet these demands.

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THE ARTIFICIAL FERTILIZATION OF QUEEN BEES

IN July last, the senior writer called the attention of the junior writer to the desirability of attempting some work in bee culture, with the object of securing pure-bred queens. One of the lines of work decided upon was that of artificial fertilization of queens. In spite of the lateness of the season, it seemed advisable to begin work at once and eight newly

emerged queens were secured before the end of the queen-producing season.

In six of the experiments, we suffered failures from natural causes; robber bees killed three and the workers refused to accept three. In a seventh case, the queen died as a result of an infection probably set up at the time of fertilization.

In an eighth experiment, apparent success seems to have followed artificial fertilization, and whatever the nature of this may be, it seems of sufficient interest to be recorded, awaiting, in the meantime, the next season for further attempts at confirmation. This queen emerged from her cell on July 23, 1914. Both wings were so rudimentary as to be almost unnoticeable. She was kept in a 3-frame nucleus, in which no drones were present and with a queen excluder applied to the entrance. On July 28, the seminal vesicles and spermatophore of a drone, which was captured in flight near one of the hives, were dissected out, teased apart, and contents diluted to facilitate manipulation. The fluid containing spermatozoa was then carefully injected through the genital opening of the queen. After this was done she was replaced in a queenless and droneless nucleus with queen-excluder applied to the hive.

By August 4, the ovaries showed considerable development, as indicated by the size of the abdomen, and on August 18 she began to deposit eggs, continuing to do so up to the time of writing, although normal queens had ceased to lay eggs for about a month. This was due probably to the stimulation given this swarm by feeding. To date, at least 3,000 eggs have been laid. The remarkable thing is that all the eggs have produced worker bees except four, which produced drones. In every respect the brood, capping of the cells, and the resulting worker bees are perfectly normal.

At present, the swarm is being strengthened and prepared for winter, so that studies of this remarkable queen may be continued next season.

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⁹ *Jour. of Agricultural Research*, 1914, 2, p. 321.